

ascent successively on the east and north sides of a LOW may reasonably be supposed to be constrained to rise after reaching the rear, as it must necessarily overrun the air of lower temperature fed into the LOW from the rear. For similar reasons air that has already risen on the east or north sides of a LOW may reach the rear and continue to rise. In this connection reference is made to the weather maps of October 27, 1918, and November 29, 1919, where, so far as surface maps may be taken as evidence, the circumstance of precipitation in the rear of a LOW, where the pressure was actually falling, indicates the possibility of air being forcibly drawn from the front to the rear of the LOW. On both maps it will be noted that the usual rise in temperature in the front of the LOW has extended well to the north of the LOW.

Of these two dates, aerological records are available for November 29, 1919, from Drexel and Broken Arrow, Okla., the observations at both stations having been taken near the ending of the precipitation. An approximately isothermal state to 2,400 meters, and a moderate lapse rate thereafter to 3,500 meters, is shown in the vertical column over Drexel, while over Broken Arrow a pronounced lapse rate is shown to 1,800 meters and an inversion immediately above. The temperatures were the same at 1,800 meters over Drexel and Broken Arrow. The lower limit of altitude at Drexel at which precipitation had occurred and to which surface air from around

the front and north of the LOW had been transported is probably defined at about 2,400 meters. Over Broken Arrow, which was then in the southwest portion of the LOW, precipitation is explained by the adiabatic gradient extending from the ground upward. This gradient probably extended above 1,800 meters earlier in the storm, as a second observation made on the same date showed rising temperature aloft.

A significant fact in connection with the generally greater and more frequent precipitation in spring than in autumn, is the spring upper-air temperatures as shown by the averages.⁸ The lag in the recovery of temperature aloft in spring is shown by the temperature records for all northern aerological stations for March and April, and a month earlier for the southern stations. It is graphically shown for Drexel in Figure 2, page 3, MONTHLY WEATHER REVIEW, January, 1920.¹² This fact was alluded to by the writer in a previous paper¹³ as indicating conditions of instability in certain circumstances of spring weather. A statistical study might show a preponderance of Pacific HIGHS at this time of year, the Pacific HIGHS showing a greater average vertical lapse rate in temperature than do those of northern origin.

¹² Gregg, W. R.: Average free-air conditions as observed by means of kites at Drexel Aerological Station, Washington, Nebr., during the period November, 1915, to December, 1918, inclusive. *Mo. WEATHER REV.*, January, 1920, 48: 1-11.

¹³ Jaki, V. E.: A kite flight in the center of a deep area of low pressure. *Mo. WEATHER REV.*, April, 1920, 48: 198-200.

551.508 (729.5) PILOT-BALLOON OBSERVATIONS AT SAN JUAN, PORTO RICO.

By OLIVER L. FASSIG, Meteorologist.

[Abstract of an informal talk before the Weather Bureau staff meeting, Washington D. C., of January 9, 1924.]

Doctor Fassig, who is in charge of the Weather Bureau service in the West Indies, presented to the Weather Bureau staff on his recent visit to Washington, D. C., a summary of the results of pilot balloon observations made at San Juan, P. R., under his supervision during the four hurricane seasons of 1920, 1921, 1922, and 1923.

San Juan, as explained by Doctor Fassig, is favorably situated with respect to the conduct of pilot balloon work. The station is well within the northeast trade region of the North Atlantic and the sky conditions are such that an ascent to 4 or 5 kilometers can be made on about 90 per cent of the days. The trades carry the balloon in a westerly direction until it reaches the so-called antitrades of the levels above 5 or 6 kilometers; it is then carried back over the observing station almost directly overhead.

A diagram was presented showing the wind direction for each day from August 29 to October 2, 1923. On nearly 50 per cent of the days the balloons reached an altitude of 10 kilometers or over. The diagram is reproduced as Figure 1.

This diagram clearly shows that in the lower levels, up to at least 4 kilometers the winds were uniformly from an easterly direction. Occasionally, as on August 13-15 and again on August 29-30, reversals set in above the 3 kilometer level and continued for a day or so. Sometimes these reversals extend to the surface, but in the 1923 season there was but a single westerly wind observed at the surface, viz, that on August 29. The gradient at times of reversal must be very weak, since at levels above about 6 kilometers easterly and westerly winds occur nearly in equal proportion—see the period August 13-21. On rare occasions the west winds form a solid current up to the top of the ascent, on one occasion

in the season of 1922 a solid SW. wind was observed from 3 to 13 kilometers.

The average wind velocity.—The inset on Figure 1 shows the average wind velocity for each month of the year from the surface up to the highest point reached. The averages for January to May, inclusive, and for December, are based upon a single year's observation, the remaining months are based on 4 years, except that June is for but 3 years. For so short a period the curve is a remarkably uniform one, with two pronounced maxima and two minima.

The group of wind roses in Figure 2 on the right shows the wind direction and frequency, in percentages, for the levels, surface up to 10 kilometers.

The curve in the center of the figure represents the average wind speed in m. p. s. all months and levels, surface up to 14 kilometers. Above that level the observations were not plentiful enough to yield a reliable average. The wind roses on the left show the direction and average speed of the wind in meters per minute up to 9 kilometers for a single season only. The wind roses on the right are also for a single season.

On October 2, 1923, a pilot balloon was observed continuously for 186 minutes. The trajectory of the balloon is shown in Figure 3. Assuming a rate of ascent of 180 meters per minute the elevation reached by this balloon must have been more than 33 kilometers. Since Doctor Fassig had some misgivings as to the accuracy of this result, he submitted the data of the ascent to the aerological investigations branch of the Central Office of the Weather Bureau for comment. The discussion that followed is given in full below. It is hoped to present a detailed discussion of the San Juan pilot balloon ascent in the near future.—A. J. Henry.